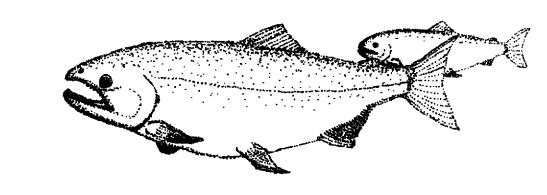


SUPPLEMENTATION INVESTIGATIONS FOR NATURALLY SPAWNING HOOD CANAL COHO SALMON





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Supplementation Investigations

for Naturally Spawning Hood Canal Coho Salmon

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ABSTRACT

Spawner and habitat surveys were conducted on selected streams flowing into Hood Canal to determine whether potential coho salmon (Oncorhynchus kisutch) habitat is currently underutilized and could be supplemented. Our initial surveys in 1992 revealed many areas that were underutilized by adult spawners. No spawners were found in many areas of the upper Dewatto and upper Tahuya Rivers. However, when we repeated spawner surveys on these streams in 1993, most of them contained adequate numbers of spawners. In 1992, spawners apparently could not migrate past some beaver dams or other obstacles due to unusually low flows. The only area that appeared to be obviously underutilized by coho salmon in both years was the streams above Tahuya Lake. These streams were further evaluated during summer low flow conditions in 1994. Few juvenile coho were found, and the streams appeared to have some good pool habitat for rearing. Based on low spawner counts and apparent availability of habitat, we recommend this area for some type of supplementation effort. We also identified several beaver ponds, marshes, and lakes that appeared to have potential as supplementation sites, however they need to be reexamined during low flows to determine whether adequate rearing habitat exists and whether it is being used by juvenile coho salmon and other fish species. Our results indicate that there are a few small, isolated areas that warrant consideration for supplementation. The best sites appear to be in the upper parts of watersheds where adult spawners may have trouble reaching in some years. Overall, supplementation potential appears to vary greatly from year to year depending on weather and relative seeding.

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INTRODUCTION

In recent years, escapement of adult coho salmon (Oncorhynchus kisutch) into Hood Canal streams has declined significantly. Most Hood Canal coho salmon stocks have been listed as depressed in the Salmon and Steelhead Stock Inventory (Washington Department of Fisheries et al. 1993). One possible management strategy for increasing production of wild coho salmon smolts is supplementation. This report describes an initial evaluation to help the Hood Canal Joint Technical Committee (JTC) determine whether supplementation of Hood Canal coho salmon is a positive alternative for increasing production.

Supplementation is as yet an unproved technology because only a small proportion of supplementation efforts have been shown to be successful at increasing natural production (Miller et al. 1990). Past work has indicated that supplementation by planting hatchery-origin stocks can sometimes be counter-productive (Nickelson et al. 1986). Hatchery fish may alter the behavior, growth, and survival of wild fish (Steward and Bjornn 1990). Generally, there is not a high expectation that fry supplementation increases smolt production unless the habitat is underseeded (Lestelle et al. 1993a). Supplementation projects have sometimes been successful at increasing sport, tribal, or commercial harvest but have not been successful at rebuilding runs. However, reestablishing runs or introductions to areas not inhabited by wild populations have shown good successes (Miller et al. 1990).

There is presently no specific information to clearly guide fisheries managers on successfully increasing natural production through supplementation without detrimental side effects. Given the limits to existing knowledge of supplementation, a long-term approach for any supplementation program should be to understand the ecology of the stock and factors limiting present production so that wise decisions can be made. Our main objective was to identify for further evaluation sites that were not utilized or obviously underutilized by cohe salmen. We believe an evaluation of Hood Canal streams is a first step in determining supplementation possibilities. To meet this objective we: 1) surveyed a variety of cohe salmen habitats for adult spawners; 2) assessed habitat condition with a cursory survey; 3) identified possible brood collection sites; and 4) reexamined selected sites during summer low flow conditions.

METHODS

To assess supplementation potential, we surveyed selected streams on both the east and west sides of Hood Canal (Table 1). Surveys were done primarily on the Dewatto River, Tahuya River above rivermile (RM) 12, Union River above RM 4 (Figure 1), and Duckabush River below RM 6.5 (Figure 2). We also conducted brief surveys on McTaggert Creek and Ripley Creek.

Dewatto, Tahuya, and Union Rivers are located in southeastern Kitsap Peninsula on the east side of Hood Canal. Many of the streams originate from lakes, ground water run-off, or swamp-like basins (Williams et al. 1975) and many have been modified by beavers (Castor canadensis). Many eastern Hood Canal streams have a low gradient with few barriers to anadromous salmonids.

Duckabush River, on the west side of Hood Canal, has its headwaters in the Olympic Mountains at an elevation of 6,250 feet. Numerous falls and cascades above RM 7.0 limit anadromous fish migration (Williams et al. 1975). Most Duckabush tributaries are steep and inaccessible to anadromous salmonids.

McTaggert and Ripley creeks are small streams on the west side of Hood Canal. McTaggert Creek is a tributary of the North Fork of the Skokomish River and Ripley Creek is a tributary of the Little Quilcene River.

1992 Surveys

We attempted to walk the main stem and all major tributaries of each stream. On most streams we started at the lowest section and proceeded upstream until the limit of coho access was reached. On some larger streams, such as Tahuya River, we walked downstream due to the difficulty in walking against the current. We did not resurvey WDFW (Washington Department of Fish and Wildlife, formerly WDF) index sites because those stream sections were surveyed weekly by WDFW personnel.

All surveys were done during the November and December adult coho salmon spawning season. We used a hip chain to measure the distance walked along each stream. Stream names, streams numbers, and rivermiles were taken from the WDF Stream Catalog (Williams et al. 1975). We recorded the number and location of live and dead spawners. We also noted the location of coho salmon redds in areas upstream of chum salmon spawning areas. Abundance of other adult salmonids, primarily chum salmon, was also noted. In some upper stream sections where no adult coho salmon were observed, we repeated spawner surveys to determine whether adult fish had moved up later in the year.

In addition to spawner surveys, we conducted habitat surveys on each stream to evaluate spawner distribution relative to available habitat and provide a basis for more detailed habitat surveys in the future. Total distance surveyed and length at individual habitat types were measured with a hip chain. For some inaccessible areas, lengths were estimated from topographic maps (1:24,000). Because our measured distances were generally longer than those estimated from topographic maps or WDF Stream Catalog, we used a correction factor of 1.1 to adjust measurements from maps. The correction factor was estimated by comparing field-measured distances to map distances between references points.

Stream reaches were categorized as confined stream, braided stream, dry streambed, large marsh/beaver pond (> 30 feet wide), and lakes. Small beaver ponds and marshes were usually in confined valleys and were included in the confined stream category. The pool:glide:riffle ratio was calculated from measured lengths of each habitat type. For small streams with numerous small habitat units, the pool:glide:riffle ratio was visually estimated. Within each 1,000 feet or change in stream reach, we visually estimated six parameters: mean width, percent overhead canopy, percent overhanging bank vegetation, gradient (nearest 0.5%), substrate type (percent silt, sand, gravel, cobble, boulder, and bedrock), and abundance of woody debris (low, moderate, or high). In addition to visual estimates of gradient, we also calculated gradient from topographic maps. No habitat information was taken during repeat spawner surveys.

We also identified sites for possible broodstock collection. Sites were evaluated in relation to abundance of spawners and accessibility.

1993-4 Surveys

During 1993, we only surveyed streams that we had identified as potential supplementation sites from the 1992 surveys. In areas where few spawners were observed during 1992 and 1993, we attempted to survey streams on a weekly basis.

After the 1993 spawner surveys, streams that were still identified as good supplementation sites were further evaluated for habitat quality and presence of juvenile coho during summer low flow conditions. We broke each stream into 50-m sections. Depending on time constraints, we systematically sampled 33-50% of the stream length. Habitat measurements were done over the entire 50-m section, while fish were sampled in every other pool or glide within each 50-m section. Juvenile coho salmon and other fish were sampled with a Smith-Root backpack electroshocker. Fish were collected with dip nets and placed in a holding bucket. After each pool or glide was completed, fish were enumerated and returned to the stream. Cutthroat trout (O. clarki) were visually broken into four size categories (< 80, 81-110, 111-140, and >140 mm fork length). Habitat units were identified according to Schuett-Hames et al. (1994) and Nickelson et al. (1992a). For each habitat unit, the length was measured along with 2-5 width measurements. Maximum depth and outlet depth were measured for each pool.

Juvenile Coho Observations. -- During 1993 and 1994 summer low-flow conditions, stream habitat surveys were done on eight independent drainages in Hood Canal (R. Tabor, unpublished data). During the habitat surveys, notes were kept on visual observations of juvenile coho. Certainly visual observations say little about the abundance of juvenile coho, but they can be used as the first step in identifying sites that are obviously underutilized by coho. Within each drainage, we attempted to survey all "coho" streams. Drainages surveyed included; Little Anderson (15.0377-85), Stavis (15.0404-6), Boyce (15.0407), Harding (15.0408-11), Anderson (15.0412-6), Union (15.0503-16), Thorndyke (17.0170-4), and Shine (17.0180-1).

RESULTS

Dewatto River

Spawner distribution, 1992-3.-- During 1992, we began adult spawner surveys on November 2, 1992 and ended on December 30, 1992. During the first 3 weeks, adult coho salmon were only observed in the lower sections of Dewatto River. Large numbers of these fish were present in holding pools. No spawning activity was observed. Adult coho salmon were not observed in the WDFW coho salmon index sections until November 25 (Figure 3). Peak counts for WDFW index sections occurred during the middle of December (Figure 3).

No adult coho salmon were observed in Dewatto River above RM 7.5 and in the WDFW index section on Windship Creek in the upper Dewatto River (RM 1.1-1.8), apparently because low flows prevented salmon access past beaver dams. Windship Creek has been used as an index section for the past 12 years and coho salmon have been observed every year except 1992 (Figure 4). In contrast, the peak count of the Dewatto River index section (RM 4.8-5.8) in 1992 was relatively high in comparison to the past 12 years. The greatest difference between the two sites occurred in 1992 (Figure 4).

Although adult coho salmon were not observed in Windship Creek and the upper reaches of the Dewatto River, they were seen immediately below beaver dams in these streams. We repeated surveys of these upper sections in case adult fish were eventually able to pass the beaver dams but even as late as December 30, no coho salmon were present. Both discharge and rainfall data indicate that November and December, 1992 were dry compared to past years (Figure 5).

The only Dewatto River tributaries used extensively by adult coho salmon were Stream 434 and lower Windship Creek (Table 2). Shoe Creek, White Creek, and Stream 422 had no apparent barriers and all were of a size useful to coho salmon, yet few adult coho salmon were present. We observed a few adult coho salmon in the lower section of Shoe Creek but no fish were seen in the upper 1.3 miles. The only coho salmon observed on White Creek and its tributary, Stream 422, were three spawners observed during a spot check near the confluence of the two streams at RM 0.3. We surveyed the upper reaches twice and the lower half mile of White Creek was surveyed weekly by WDFW chum salmon index personnel.

Streams 428, 429, and 437 had adequate water flow and spawning habitat in upstream sections but flows were sub-gravel near the streams' mouth apparently blocking fish migration. Flows at the mouth of Stream 435 were also quite low. Fish access to these streams may require a large fall freshet, which did not appear to occur during our survey period.

Migration of adult salmonids in Stream 426 appeared to be blocked by a culvert 1,045 feet from the mouth of the stream. There is approximately 4,000 feet of good spawning habitat above the culvert. We observed two coho salmon and six redds in the section below the culvert but no redds or fish were seen above the culvert. A culvert on Stream 429 also appears to block access to upper reaches.

<u>Spawner distribution. 1993-4</u>. -- We conducted spawner surveys in Dewatto basin streams from December 3-14. Adult coho salmon were not observed in the WDFW coho salmon index sections until December 3 (Figure 3). Peak counts for WDFW index sections occurred on December 10 (Figure 3).

During 1993-4 surveys, coho salmon spawners were abundant in many upper tributary areas where no spawners were observed during 1992-3 surveys (Table 3). Peak flow conditions in December 1993 were substantially higher than in November-December 1992 (Figure 5). A large rain event occurred from December 7-10 (14.7 cm of rain in Bremerton, Washington). High flows and destruction of several beaver dams apparently allowed coho spawners access to the upper tributaries.

<u>Habitat Survey</u>. -- The lower 3.5 miles of Dewatto River is a low gradient section with good habitat for coho and chum salmon. Above this section, the valley widens with frequent beaver ponds and marshes. The channel is mostly unconfined until RM 8.1.

The upper areas of Stream 437A and Windship Creek appeared to have substantial rearing area for juvenile coho salmon. Approximately 500 ft above the index section on Windship Creek is a large beaver pond (≈9 acres) that appears to be impassable. A series of beaver ponds on Stream 437A also has over 10 acres of available habitat. Additionally, Stream 437B consisted mostly of a series of beaver ponds for 1,750 feet.

Habitat in the lower 1.9 miles of Shoe Creek appeared to be good, the mean width was 9.3 feet and the gradient is \$2.4%. Some good pool habitat was present, especially from RM 1.5 to 1.9. No barriers were observed, although an impassable cascade is listed at RM 1.2 in the WDF Stream Catalog. Unlike the upper Dewatto River, there were few beaver dams to hinder migration of salmonids in Shoe Creek. The upper section (RM 1.9-2.3) was dry as late as December 3, but some flows were observed at the outlet of Shoe Lake (RM 2.3) on December 14 and January 15. Both Shoe Lake and Larsen Lake could serve as stocking sites for juvenile coho salmon although current fishery management of these lakes is unknown. Shoe Creek tributary 425 is small and is probably not important for coho salmon. Stream 424A begins at the outlet of Larsen Lake at an impassable culvert and flows \$4,000 feet (3.5% gradient) to Shoe Creek.

White Creek and its tributary, Stream 422, have a moderately steep gradient (3.9% and 5.9%, respectively) which may limit fish migration. A large marsh at RM 1.6 to 1.8 on White Creek could provide a good area for coho salmon rearing. The upper section between Cady Lake (RM 2.0) and RM 1.8 was mostly dry throughout our study period.

Other tributaries were similar to Shoe Creek and White Creek. They tend to have a moderate gradient, 10-30% pool habitat, and moderate level of woody debris.

Broodstock collection. The most accessible places for broodstock collection would be along Dewatto Road at Stream 434 or on the mainstem at RM 7.5. Most tributaries' lower sections were accessible but few spawners were observed.

Tahuya River

Spawner Distribution, 1992-3. -- We periodically surveyed Tahuya River from November 24 to December 31. Peak counts for WDFW index sections occurred from December 16 to 23 (Figure 3). We observed coho salmon spawners from RM 12 to RM 15.8. Spawners were particularly abundant on December 15 from RM 15 to RM 15.8. Although spawning habitat was limited in some areas (RM 14.1 to 15.8), spawning was observed on leading edges of old beaver dams and in short stream sections between beaver ponds. No adult coho salmon were observed above a large beaver dam at RM 15.8. Observation of spawners was difficult from RM 15.8 to 17.8 because the habitat was mostly marshes and beaver ponds. The Tahuya River from RM 17.8 to Tahuya Lake (RM 19.4), and streams above Tahuya Lake, appear to have good spawning habitat yet no fish were seen. We repeated surveys of upper Tahuya River area, but even as late as December 30, no coho salmon were present. Similarly to Dewatto River, low flows apparently prevented adult coho salmon access past beaver dams.

Small tributaries, which have been used as spawning areas, may have had unusually few spawners in 1992 due to low flows. For example, of the five index sections in the Tahuya River system, the smallest two streams, Andy's Creek (458) and Erdmann Lake Creek (459), had few spawners. We observed few fish in tributaries 471 and 472.

Spawner Distribution, 1993-4. -- Similarly to the Dewatto River tributaries, we observed coho spawners in many areas of the Tahuya River basin where we did not observe any spawners in 1992-3. The upper extent of coho spawners on the mainstem Tahuya River in 1992-3 was RM 15.8, while in 1993-4 spawners were observed up to the base of the Tahuya Lake Dam at RM 19.6. Additionally, two spawners were observed above the Tahuya Lake Dam in Gold Creek.

Juvenile Coho Survey, 1994 .-- Because the tributaries above Tahuya Lake had few spawners, we further evaluated these sites for the presence of juvenile coho salmon. Stream 475 appeared to be mostly dry and was not evaluated. Results from electroshocking collections appeared to be similar to results from spawner counts. No juvenile coho were collected in Tahuya River (RM 20.4 to 20.7). In Gold Creek, where only two coho spawners were observed, juvenile coho were present but not abundant. We sampled a total of 1,908 ft² of pool habitat and only 19 juvenile coho were collected (Table 5). If we assume that we were able to collect 65% of the coho in the area sampled (R. Peters, USFWS, personal communication) and then expand to the other areas not sampled, we estimate the entire reach contained 111 juvenile coho. Based on densities of juvenile coho observed in various habitat types in Oregon coastal streams (Nickelson et al. 1992a), we estimated that the reach could support 1,419 juvenile coho. The other site on Tahuya River (RM 20.4 to 20.7) could support 1,407 juvenile coho. Data from Big Beef Creek indicate that 0.3142 smolts are produced per square meter of low-flow habitat. Based on this value, the Gold Creek reach could produce 467 smolts and the Tahuya River section 315 smolts. Because we did not sample the upper stream section (1,132 ft in length) of Gold Creek, the total number of coho smolts and juvenile coho would be somewhat higher. However, this section contains mostly riffles and cascades with few pools. The number of juvenile coho in the Tahuya River site would also be somewhat higher because of some available habitat in stream 477A.

In both streams cutthroat trout were abundant (Table 5). A few adult size cutthroat (> 180 mm) were collected in Gold Creek. Speckled dace (Rhinichthys osculus) and sculpin (Cottus sp.) were also common in Gold Creek.

Habitat Survey. -- Of the total stream length surveyed on Tahuya River (RM 12.0-21.2), 35% consisted of marshes and beaver ponds. From a physical habitat standpoint, the Tahuya River area above RM 15.8 has a large potential for supplementation. Tahuya Lake could provide a large area for juvenile coho salmon rearing and it has a total of 1.2 miles of spawning and rearing habitat in its two tributaries. Summer low-flow habitat surveys of the tributaries above Tahuya Lake indicated that there was some good available habitat (Table 6). Both contain a high percentage of pool habitat (Table 6). Although we did not measure discharge, flows in Gold Creek visually appeared to be good while flows in Tahuya River RM 20.3-20.8 were low. Both tributaries appear to have potential for supplementation, but the major drawback of supplementation in this area is possible interactions with introduced species. Tahuya Lake contains largemouth bass (Micropterus salmoides) and bluegill (Lepomis macrochirrus). However, these species were not collected in the tributaries.

Panther Lake and a marsh below the lake also contain a large amount of rearing habitat. There is no tributary above Panther Lake for spawning but juvenile coho salmon may move upstream for summer or winter habitat. Panther Lake reportedly has had a fish screen at the outlet but we were unable to locate it. The lake is stocked annually with catchable rainbow trout (0. mykiss). There is an approximately 1,500 ft stream section below the marsh that appears to have suitable spawning area.

Broodstock Collection. -- In the upper Tahuya River, spawners would best be collected just upriver from Bear Creek Road bridge at RM 15.

Union River

Spawner Distribution. -- In the Union River system, 1992-3 surveys were conducted from RM 4.0 to an impassable barrier (McKenna Falls) at RM 6.6 and were only done on December 22 and 23. We observed few adult coho salmon. The peak WDFW index count (RM 5.3 to 6.0) of 17 fish was recorded the same week we did our surveys. Seventeen fish is the lowest peak count for Union River in the past 12 years. There were a few beaver dams in our survey area but all were relatively small. Counts on index sections of two tributaries were also low. Therefore, few coho salmon apparently returned to spawn in Union River system.

No additional surveys were done in 1993-4. However, peak counts of WDFW index sections returned to more typical levels in 1993-4. The upper reaches appeared to be well seeded with coho spawners.

<u>Juvenile Coho Observations</u>. — In addition to spawner surveys, we also kept notes on visual observations of juvenile coho during 1994 summer low-flow habitat surveys (R. Tabor, unpublished data). The mainstem and most tributaries were surveyed. Generally, juvenile coho appeared to be well distributed throughout the area surveyed. The only area where no juvenile

coho were observed was an unnamed LB tributary at RM 0.5. Fish may have been difficult to observe due to tannin-colored water. We surveyed the lower 0.5 mile of the stream. Above this is an apparent impassable culvert and a beaver pond which could serve as a good overwintering site. The area above the beaver pond was not surveyed.

Habitat Survey. -- From RM 4.0 to 5.3, the Union River consists of a low gradient stream with occasional beaver ponds. Although rearing habitat was abundant, spawning habitat appeared to be marginal. The substrate consisted mainly of silt, sand and small gravel. The spawning habitat appeared to be somewhat degraded from residential home development and agricultural practices which may be increasing the sediment load. Riparian vegetation had been removed in many places and bank erosion was evident in some areas.

Near McKenna Falls (RM 6.4 to 6.6) the gradient is steep and has a limited amount of coho salmon habitat. From RM 6.0 to 6.4 the gradient moderates and contains good spawning and rearing habitat.

The East Fork Union River has extensive beaver ponds and wetlands in the lower sections but was mostly dry above RM 1.3. Other tributaries appeared to have limited habitat for coho salmon due to impassable barriers or poor flow conditions.

<u>Broodstock Collection</u>. -- Because few coho salmon were observed, we were unable to identify any broodstock collection locations.

Duckabush River

<u>Spawner Distribution</u>. -- In the Duckabush River system, we observed 6 adult coho salmon in the lower section of the main stem, none in the upper section, 13 in Stream 352, and none in Stream 362. A peak count of 49 coho salmon was observed on November 25 by WDFW personnel in the Duckabush River index section (RM 0.1-2.3). Because most of our counts were done over two weeks earlier and only repeated in the tributaries, we probably missed most of the run. No additional surveys were done in 1993-4.

<u>Habitat Survey</u>. — The upper section contained mostly riffle habitat while the lower section contained an even proportion of pool, riffle, and glide habitat. Woody debris was sparse throughout both river sections which may limit coho salmon production. The accessible section of Stream 362 is short but could provide some spawning habitat. No habitat survey was done on Stream 352.

<u>Broodstock Collection</u>. -- Stream 352 has good access and may be a good site for broodstock collection. On much of Duckabush River, access is difficult, however broodstock collection may be feasible on the lower section.

Other Streams

<u>Spawner Distribution.</u>— McTaggert Creek and Ripley Creek were each surveyed once, December 7 and 23, respectively. Four adult coho salmon were observed in McTaggert and none were seen in Ripley Creek.

Juvenile Coho Observations. -- In addition to Union River, we kept notes on visual observations of juvenile coho during 1993 and 1994 summer low-flow habitat surveys of several independent drainages. During 1993 surveys, juvenile coho were not observed in the entire Harding Creek and Thorndyke Creek drainages and the upper section of Shine Creek. The lower sections of Thorndyke Creek were resurveyed in 1994 and juvenile coho appeared to be abundant. Beaver dams, located near the estuary, apparently had blocked coho migration in 1992-93. High peak flows and destruction of the lower beaver dam apparently allowed fish passage in 1993-94.

Two adult coho were observed in Harding Creek during spawner surveys in 1993-94 (P. Bahls, Port Gamble Fisheries, personal communication). On August 19, 1994, we also checked for the presence of juvenile coho with a backpack electroshocker. Thirty-two juvenile coho salmon were collected in 12.8 minutes of shocking. However, no juvenile coho were collected to the lower sections of tributaries 409 and 410. Harding Creek and its tributaries appears to be a potential site for supplementation, however further evaluation of juvenile coho density is needed.

Between RM 0.9 and 1.3 of Shine Creek there were several beaver dams which appeared to limit adult passage. The beaver ponds (RM 0.9-1.6) and 1.1 miles of stream habitat above the beaver ponds appeared to have good coho rearing habitat.

<u>Habitat Survey</u>. -- McTaggert Creek appeared to be mostly a steep gradient stream with few pools and few good spawning sites. Ripley Creek appeared to have good spawning habitat. However, recent habitat surveys indicated most of the stream is dry during the summer and has limited rearing habitat (P. Faulds, Point No Point Treaty Council, personal communication).

Summer low-flow habitat surveys of the Harding Creek drainage indicated there are good summer flows. Most of the best rearing habitat is located in a small stretch of Harding Creek from RM 0.3 to 0.8. The other stream sections of Harding Creek and tributaries were composed mostly of riffles and cascades with few pools.

DISCUSSION

The only thing that is clear about coho salmon supplementation is that simply adding more fish to a stream does not necessarily increase production (Miller et al. 1990). There are a number of dynamic and interactive factors determining whether supplementation is effective, as discussed below. Therefore, our evaluation of Hood Canal spawner distribution, stream habitat, and presence of juvenile coho was the first step in determining supplementation possibilities.

<u>Spawner distribution</u>. — During our 1992 surveys, we revealed many areas that were underutilized by coho spawners. However, in most of these areas spawners were present during 1993-94 surveys. The lack of spawners appears to have been primarily due to unusually low flows during November and December, 1992.

In some years, marshes and beaver ponds on the upper reaches of Dewatto and Tahuya Rivers appear to be inaccessible to coho salmon. In years of normal flows, adult coho salmon may use the upper reaches and small tributaries. Fall freshets may be necessary to breach beaver dams or allow sufficient flow for fish to ascend the dams.

Some accessible streams appeared to have few adult coho salmon present given the amount of available habitat. Before supplementation efforts are undertaken, the streams need to be monitored for a few years to ensure they are consistently underseeded. In upper Tahuya River and Gold Creek, we surveyed 1.3 miles of stream yet only saw two adult coho salmon. Past records indicate these streams are capable of supporting much larger run sizes. For example in 1986 a total of 147 adult spawners were observed between the two streams.

Culverts appeared to block fish passage in two tributaries of the Dewatto River, Streams 426 and 429. Both streams appeared to be similar in size and quality to nearby Stream 434, which had abundant coho salmon spawners present. Supplementation would allow the habitat above the culverts to be utilized. The owner of the road and culvert on Stream 426 agreed to lower the culvert to allow for better fish passage. If the culvert is repaired, spawner surveys should be continued to determine whether the stream becomes seeded on its own.

During low flow years such as 1992-93, access to some tributaries may be blocked by the lack of substantial flow at the creek's mouth. The accumulation of sediments appeared to cause water flow to be mostly subgravel. Upper reaches often had good flows and good spawning sites but adult fish apparently did not utilize these areas. Whether past land-use practices have increased the accumulation of sediments is difficult to determine. In Stream 429 a culvert on the Dewatto Bay Road appears to have caused large downcutting of a 1,000 foot section of stream, resulting in the accumulation of sediment at the stream's mouth. Madej (1982) found that land-use changes greatly increased sediment transport rates in Big Beef Creek and caused an increase in channel width and decrease in depth, especially at the creek's mouth.

Time of year. -- Streams also need to be reexamined during summer low flows to determine whether adequate rearing habitat exists, and what proportion of potential habitat is being used by juvenile coho salmon and whether other fish species are present. Surface area should be estimated to determine potential habitat. In lentic habitats such as lakes and marshes, dissolved oxygen and temperature should also be measured. It is important to understand which habitats are limiting production in each season.

Introduced species. -- Exotic species such as largemouth bass and bluegill, both predators and competitors of juvenile coho salmon, have been stocked into many Hood Canal lakes and may occur in other habitats. In the Tenmile Lakes system in Oregon, coho salmon spawners declined dramatically following the introduction of largemouth bass (Reimers 1989). Historically, much of the smolt production in the Tenmile Lakes system occurred in lake environments. Currently, smolt production occurs only in the upper tributaries. Reimers (1989) proposed to trap fry entering the lakes and rear the fish in a hatchery

until November 1 when they could survive well in the lake. Marshes, beaver ponds, and low gradient streams may also be potential habitat for exotic species. Besides exotic species, introductions of hatchery fish may have an adverse effect on coho salmon production. In the Hood Canal area, rainbow trout are stocked into many lakes and cutthroat trout (O. clarki) are stocked into some marshes and beaver ponds. Although coho salmon may naturally coexist with these species, artificially high population levels of introduced fish may cause increased predation and competition.

Habitat type. -- An important factor that needs to be considered when supplementing coho salmon is the type of habitat to be stocked. Miller et al. (1990) concluded that supplementation programs have a better chance of success if stocked fish rear in lakes or ponds. Juvenile coho salmon in lakes and ponds can have good survival rates (Peterson 1982) and growth may be faster than in streams (Irvine and Johnston 1992). Nickelson et al. (1992b) concluded that the development of off-channel habitat has the greatest potential to increase production of coho salmon smolts in Oregon coastal streams.

Beaver ponds and other similar habitats are quite abundant in the Dewatto and upper Tahuya drainages. In Oregon coastal streams (Nickelson et al. 1992a) and southeast Alaska streams (Bryant 1984; Murphy et al. 1989) beaver ponds were important rearing areas for coho salmon. Beaver ponds may be particularly important for winter habitat (Nickelson et al. 1992a). Importance of marshes and beaver ponds may also be variable from year to year depending on rainfall and temperature. In the early 1980's, WDFW stocked some of the marshes and beaver ponds in the Tahuya River system, but little evaluation was done after the fish were stocked. The exception was at Long Marsh on upper Little Tahuya Creek which had a smolt trap approximately 2 miles below the stocking site. An estimated 700 hatchery smolts were collected at the trap site which indicated a survival rate of at least 1.3% (Lenzi 1984). The actual survival rate was likely somewhat higher due to fish not counted when the trap washed out, fish that reared below the trap site, and some fish outmigrating as 2+ smolts. The low survival of these hatchery fish was believed to be primarily a function of less than average stream flows in the summer of 1979. No information is known where the fish reared after stocking.

Some beaver ponds and marshes at the headwaters of streams may have little spawning habitat above them and may be historically underseeded unless juvenile coho salmon can migrate upstream past the beaver dams. Management strategies for these areas includes: stocking fish, removal of beaver dams, and the use of small, inexpensive fish ladders to allow juvenile coho salmon passage into beaver ponds (S. Jenks, WDFW, personal communication).

In addition to beaver ponds, western Kitsap Peninsula also has numerous lakes. Recent work in British Columbia indicates lakes are important for juvenile coho salmon, and smolt production may exceed that in adjacent streams (Swales 1988; Irvine and Johnston 1992; Holtby et al. 1993). The ratio of lake perimeter to stream length may be used as an index of the relative potential importance of lake habitat for coho salmon rearing in a watershed (Irvine and Johnston 1992). Within Hood Canal, little is known about the historical

importance of lakes for coho production. Currently though, access to many lakes in the Hood Canal area is blocked by screens. In Haven Lake Creek, adult coho salmon have been able to pass the fish screen at the outlet of Haven Lake in some high flow years and spawn above the lake. The following year, juvenile coho salmon were present in Haven Lake and grew to a large size (D. Collins, WDFW, personal communication). Within the area we surveyed, Panther Lake and Tahuya Lake are accessible by coho salmon. Shoe Lake, Larsen Lake, and Erickson Lake do not appear to be accessible but could serve as stocking sites.

Stocking juvenile coho salmon above natural barriers may also be a viable strategy for supplementation, assuming issues regarding native fish were not an obstacle. In other regions this strategy has been successful (Miller et al. 1990; Hurst 1993). The major natural barrier to anadromous salmonids on Kitsap Peninsula is McKenna Falls on Union River. Above McKenna Falls are 2 miles of stream habitat and Union River Reservoir, a 64-acre (3 miles of shoreline) domestic water supply reservoir for the City of Bremerton. Additionally, there are approximately 0.6 miles of stream habitat and 0.7 miles of marsh/beaver pond habitat above a waterfall on Gold Creek. Many western Hood Canal streams, such as the Duckabush River, Hamma Hamma River, and Lilliwaup River, have large amounts of potential habitat above natural barriers.

Supplementation evaluation .-- Much remains to be learned about the effectiveness of coho salmon fry supplementation before the technique can be widely applied. Early results from extensive studies on small Clearwater River (coastal Washington) tributaries indicate that supplementation may increase production, at least through low summer flow stage but only when tributaries have been underseeded (R. Peters, USFWS, personal communication). However, in cases where streams were naturally fully seeded, adding fry to the streams apparently simply displaced wild fish. It is also important to understand the point in the life history where production is limited. example, increasing summer production will do little good if that production is lost the following winter. Most likely, each system is different and limits probably vary from year to year depending on weather and relative seeding. Therefore, each system needs careful study of available habitat at each critical stage with consideration for the number of fish available that year to seed the habitat (Lestelle et al. 1993b). Evaluation of current WDFW supplementation efforts in northwest Hood Canal streams (mainly Leland Creek and Tarboo Creek) may also add valuable information. In any case, all future supplementation should be carefully evaluated at every possible step.

RECOMMENDATIONS

- 1) Based on spawner counts and habitat assessment, the streams above Tahuya Lake appeared to have the best supplementation potential of the streams we examined.
- 2) A few sites appeared to have some potential for supplementation, however further evaluation during low flow conditions is needed. These sites include:
 - a) Harding Creek
 - b) Upper Shine Creek
 - c) Stream 362 (Duckabush LB tributary)
 - d) White Creek and tributary 422
- 3) We believe there are several lakes and beaver ponds that should be considered for supplementation. Further evaluation is needed to determine use by resident and anadromous fish and summer dissolved oxygen and temperature levels. These sites include:
 - a) Panther Lake
 - b) Erickson Lake
 - c) Shoe Lake and Larsen Lake
 - d) Tahuya Lake
 - e) Beaver pond on upper Windship Creek
 - f) Beaver ponds on Dewatto tributary 437A
 - g) Beaver ponds on East Fork Union River
 - h) Beaver ponds on Shine Creek
- 4) Streams above impassable culverts should also be considered as potential supplementation sites. These sites include Dewatto tributaries 426 and 429.
- 5) Evaluation should include:
 - a) Continuing spawner counts to assess adult coho salmon abundance and distribution.
 - b) Examining sites during summer low flow conditions to assess extent of carrying capacity currently being used.
 - 1) Estimate surface area.
 - 2) Determine density of juvenile coho salmon and other species.
 - 3) Assess water quality (temperature and dissolved oxygen) in beaver ponds and marshes.
 - c) Examining overwintering habitat sites during winter to assess whether juvenile coho salmon migrate there.
 - d) Requiring extensive evaluation before, during, and after any fish are stocked in a supplementation effort.

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Table 1. -- List of streams surveyed during coho salmon spawning season (November 1992 - January 1993) for supplementation evaluation.

Local stream names are given in parentheses. WRIA = Water
Resource Inventory Area; RM = rivermile.

		IA +	RM	RM
Stream Name		eam ber	low end	upper end
Name	Nuii	mer		
Dewatto River	15	420	0	4.0
Dewatto River	15		7.5	8.7
unnamed (White)	15	421	0	2.0
unnamed	15	422	0	0.9
unnamed	15	423	0	0.6
unnamed (Shoe)	15	424	0	1.9
unnamed	15	424A	0	0.7
unnamed	15	425	0	0.2
unnamed	15	426	0	0.8
unnamed	15	429	0	1.0
unnamed	15	434	0	1.3
Ludvick Lake	15	435	0	0.6
unnamed (Windship)	15	436	0	0.5
unnamed	15	437	0	0.8
unnamed	15	437A	0	0.9
unnamed	15	437B	0	0.3
Tahuya River	15	446	12.0	21.8
unnamed (Buffoon)	15	470	1.2	1.5
unnamed	15	471	0	0.3
unnamed	15	472	0	0.3
Gold Creek	15	474	0	0.8
unnamed	15	475	0	0.2
Tin Mine Creek	15	476	0	0.4
unnamed	15	477A	0	0.3
Union River	15	503	4.0	5.3
Union River	15	503	6.0	6.6
East Fork Union R.	15	514	0	0.3
McTaggert Creek	16	105	0	3.0
Duckabush River	16	351	0.2	2.3
Duckabush River	16	351	4.4	6.3
unnamed	16	352	0	0.4
unnamed	16	362	0	0.2
Ripley Creek	17	89	0	0.7

Table 2. -- Number of adult coho and chum salmon spawners and coho salmon redds from November and December 1992 surveys in Hood Canal streams.

Redds were not counted in areas that overlapped with chum salmon distribution. WRIA = Water Resource Inventory Area; RM = rivermile.

	ופָע	[A +		RM	RM			C	oho Sa	lmon			Chum 8	Salmon
Stream Name	Sti	ream mber	Date	l ow end	upper end	Length (miles)	# Live	# Dead	# Total	#/mile	# seen	# Redds	# Total	#/mile
Dewatto	15	420	02-Nov	0.0	0.7	0.7	0	0	0	0.0	80		461	658.6
Dewatto	15	420	05-Nov	0.7	1.8	1.1	416	ŏ	416	378.2	85		374	340.0
Dewatto	15	420	16-Nov	1.8	3.2	1.4	96	Ō	96	68.6	40		354	252.9
Dewatto	15	420	18-Nov	3.2	4.0	0.8	5	ŏ	5	6.3	10		Ö	0.0
Dewatto	15	420	24-Nov	7.5	7.7	0.2	26	ŏ	26	130.0	80	16	ŏ	0.0
Dewatto	15	420	03-Dec	7.9	8.1	0.2	Ō	ŏ	ā	0.0	80	Ö	Õ	0.0
Dewatto	15	420	08-Dec	7.9	8.7	0.8	ŏ	ŏ	ŏ	0.0	60	ŏ	ŏ	0.0
Dewatto	15	420	15-Dec	7.9	8.1	0.2	ŏ	Ö	ŏ	0.0	90	ŏ	ŏ	0.0
Dewatto	15	420	30-Dec	7.9	8.1	0.2	ŏ	ŏ	Ŏ	0.0	90	1	ŏ	0.0
White	15	421	04-Dec	0.0	1.6	1.6	0	0	0	0.0	90		849	530.6
White	15	421	07-Dec	1.6	2.0	0.4	Ŏ	Ŏ	Ď	0.0	80	0	Ô	0.0
White	15	421	14-Dec	0.4	1.6	1.2	3	ŏ	3	0.0	90	ĭ	ŏ	0.0
unnamed	15	422	14-Dec	0.0	0.9	0.9	0	0	0	0.0	95		170	188.9
unnamed	15	423	09-Dec	0.0	0.6	0.6	3	6	9	15.0	80	7	1	1.7
Shoe	15	424	23-Nov	0.0	1.6	1.6	4	0	4	2.5	90		44	27.5
Shoe	15	424	03-Dec	1.6	1.9	0.3	õ	ŏ	Õ	0.0	90	0	77	0.0
Shoe	15	424	14-Dec	0.3	1.6	1.3	1	1	2	1.5	90	6	Ö	0.0
unnamed	15	424A	14-Dec	0.0	0.7	0.7	C	0	0	0.0	80	0	0	0.0
unnamed	15	425	14-Dec	0.0	0.2	0.2	0	0	0	0.0	90	0	0	0.0
unnamed	15	426	09-Dec	0.0	0.8	0.8	1	1	2	2.5	80	6	0	0.0
unnamed	15	429	07-Dec	0.0	1.0	1.0	0	0	0	0.0	90	0	0	0.0
unnamed	15	429	09-Dec	0.1	0.3	0.2	Ŏ	ŏ	Ö	0.0	90	Õ	Ö	0.0
unnamed	15	434	15-Dec	0.0	1.3	1.3	53	4	57	43.8	90	60	0	0.0
Ludvick Lake	15	435	16-Dec	0.0	0.6	0.6	0	0	0	0.0	90	0	0	0.0
Windship	15	436	25-Nov	0.0	0.5	0.5	24	0	24	48.0	80	18	0	0.0
unnamed	15	437	15-Dec	0.0	8.0	0.8	0	0	0	0.0	95	0	0	0.0
unnamed	15	437B	25-Nov	0.0	0,3	0.3	0	0	0	0.0	50	0	0	0.0
unnamed	15	437A	03-Dec	0.0	0.9	0.9	0	0	0	0.0	90	0	0	0.0
unnamed	15		15-Dec	0.0	0.5	0.5	ŏ	ŏ	ŏ	0.0	90	ŏ	ŏ	0.0
unnamed	15		30-Dec	0.0	0.5	0.5	ō	ŏ	Ŏ	0.0	90	ŏ	ŏ	0.0
Tahuya	15	446	24-Nov	12.0	13.0	1.0	6	0	6	6.0	75	2	0	0.0
Tahuya	15	446	30-Nov	13.0	15.0	2.0	13	ĭ	14	7.0	30	11	ŏ	0.0
Tahuya	15	446	01-Dec	18.2	19.4	1.2	0	ó	0	0.0	90	0	Ö	0.0
Tahuya	15	446	02-Dec	15.0	16.3	1.3	7	ŏ	7	5.4	70	8	Ö	0.0
Tahuya	15	446	10-Dec	20.5	20.9	0.4	ó	Ö	ó	0.0	90	0		
Tahuya	15	446	16-Dec						_				0	0.0
Tahuya Tahuya	15	446	18-Dec	15.0	15.8	0.8	49	2	51	63.7	80	36	Ŏ	0.0
Tahuya Tahuya	15	446	18-Dec	17.8	18.2	0.4	0	0	0	0.0	75 70	0	0	0.0
Tahuya Tahuya	15	446	18-Dec	18.2	19.4	1.2	0	0	0	0.0	70	0	0	0.0
Tahuya Tahuya	15	446	30-Dec	20.6	20.8	0.2	0	0	0	0.0	90	0	0	0.0
				18.2	19.4	1.2	0	0	0	0.0	80	0	0	0.0
Tahuya Tahuya	15 15	446 446	30-Dec 31-Dec	20.6 17.4	20.8 17.7	0.2 0.3	0	0	0	0.0 0.0	90 80	0 1	0	0.0 0.0
Buffoon	15	470	31-Dec	1.2	1.5	0.3	0	0	0	0.0	80	0	0	0.0
unnamed	15	471	16-Dec	0.0	0.3	0.3	3	0	3	10.0	50	2	0	0.0
ur e ranneu						0.5	,	•	_		20	-	v	0.0

Table 2, continued.

	LIO 1	(A +		RM	RM			C	oho Sa	lmon			Chum S	Salmon
Stream Name	Sti	ream mber	Date	l ow end	upper end	Length (miles)	# Live	# Dead	# Total	#/mile	# seen	# Redds	# Total	#/mile
Gold Gold	15 15	474 474	01-Dec 10-Dec	0.0	0.8	0.8 0.7	0	0	0	0.0	95 60	0	0	0.0
Gold Gold	15 15	474 474	18-Dec 30-Dec	0.1	0.5 0.5	0.4	0	0	0	0.0 0.0	90 90	0	0	0.0 0.0
Tin Mine	15	476	30-Dec	0.0	0.4	0.4	0	0	0	0.0	90	0	0	0.0
unnamed	15	477A	18-Dec	0.0	0.3	0.3	0	0	0	0.0	90	0	0	0.0
Union Union Union	15 15 15	503 503 503	22-Dec 23-Dec 23-Dec	4.9 6.0 4.0	5.3 6.6 4.9	0.4 0.6 0.9	1 0 1	0 0 0	1 0 1	2.5 0.0 1.1	80 80 70	13 5 11	0 0 0	0.0 0.0 0.0
unnamed	15	512		0.2	1.1	0.9	0	0	0	0.0		0	0	0.0
East Fork Union	15	514	21-Dec	0.0	0.3	0.3	0	0	0	0.0	70	0	0	0.0
McTaggert	16	105	07-Dec	0.0	3.0	3.0	3	1	4	1.3	85	8	0	0.0
Duckabush Duckabush Duckabush	16 16 16	351 351 351	06-Nov 10-Nov 24-Nov	0.2 4.4 5.3	2.3 6.3 5.4	2.1 1.9 0.1	5 0 0	1 0 0	6 0 0	2.9 0.0 0.0	20 95 95		525 0 0	250.0 0.0 0.0
unnamed unnamed	16 16	352 352	24-Nov 22-Dec	0.0	0.4	0.4 0.4	12 0	1 2	13 2	32.5 5.0	95 95	7 2	0	0.0 0.0
unnamed unnamed unnamed	16 16 16	362 362 362	12-Nov 24-Nov 22-Dec	0.0 0.0 0.0	0.2 0.2 0.2	0.2 0.2 0.2	0 0 0	0 0 0	0 0 0	0.0 0.0 0.0	95 95 95		0 0 0	0.0 0.0 0.0
Ripley	17	89	23-Dec	0.0	0.7	0.7	0	0	0	0.0		0	0	0.0

Table 3. -- Number of adult coho and chum salmon spawners and coho salmon redds from December 1993 to January 1994 surveys in Hood Canal streams. WRIA = Water Resource Inventory Area; RM = rivermile.

	LID	(A +		RM	RM			C	oho Sa	lmon		Chum	Salmon
Stream Name	St	ream mber	Date	low end	upper end	Length (miles)	# Live	# Dead	# Total	#/mile	# seen	# Total	#/mile
Dewatto	15	420	14-Dec	7.9	8.7	0.8	49	0	49	61.3	90	0	0.0
White	15	421	03-Dec	0.0	0.2	0.2	0	0	0	0.0	90	36	180.0
unnamed	15	422	03-Dec	0.0	0.3	0.3	C	0	0	0.0	90	199	663.3
Shoe Shoe	15 15	424 424	03-Dec 13-Dec	0.1 0.1	1.3 1.3	1.2 1.2	3 15	0	3 15	2.5 12.5	70 80	0	0.0 0.0
unnamed unnamed	15 15	426 426	03-Dec 13-Dec	0.0	0.8 0.4	0.0 0.4	0	0	0	0.0 15.0	80 80	0	0.0
unnamed unnamed	15 15	429 429	08-Dec 14-Dec	0.0	0.3	0.3 0.7	0	0	0	0.0 12.9	70 90	0	0.0
Ludvick Lake	15	435	14-Dec	0.0	0.4	0.4	3	0	3	7.5	90	0	0.0
unnamed	15	437A	14-Dec	0.0	0.9	0.9	27	1	28	31.1	80	0	0.0
Tahuya Tahuya Tahuya	15 15 15	446 446 446	08-Dec 08-Dec 13-Dec	20.6 15.0 18.3	20.8 15.7 19.4	0.2 0.7 1.1	0 0 9	0 0 0	0	0.0	90 40	0	0.0
Tahuya Tahuya	15 15	446 446	13-Dec 20-Dec	20.3	20.8 20.8	0.5 0.5	0	0	9 0 0	8.2 0.0 0.0	30 90 90	0 0 0	0.0 0.0 0.0
Tahuya Tahuya	15 15	446 446	29-Dec 10-Jan	20.3 20.3	20.8 20.8	0.5 0.5	0 0	0	0 0	0.0 0.0	90 90	0	0.0 0.0
unnamed	15	472	13-Dec	0.1	0.3	0.2	3	0	3	1.5	70	0	0.0
Gold Gold	15 15	474 474	08-Dec 13-Dec	0.3 0.1	0.5 0.6	0.2 0.6	0 2	0	0 2	0.0 3.3	80 80	0	0.0
Gold Gold	15 15	474 474	20-Dec 29-Dec	0.1	0.6 0.6	0.5 0.4	Ö 0	ŏ	0	0.0	80 80	0	0.0
unnamed	15	475	20-Dec	0.1	0.3	0.2	0	0	0	0.0	90	0	0.0

Table 4. -- Summary of habitat survey data collected for Hood Canal streams from November 1992 to January 1993. Reach Type: 1 = wetted stream, 2 = dry stream, 3 = large beaver pond/marsh, 4 = lake, 5 = braided stream. Glid = glide; Rif = riffle; Ledg = ledge/bedrock; Bou = boulders; Cobb = cobble; Grav gravel; Org = Organic debris; % Can = % overhead canopy; % OHBV = % overhanging bank vegetation; WD = abundance of woody debris (1 = few, 2 = medium, 3 = abundant).

	WRIA		₹.				!		Perc Habit	Percent Habitat type			Percent	Substrat	ste					
Name	Number Number	Dates	5 E		Distance (ft)	Reach	fig.	Grade	Pool	Glid	Rif Le	edg Bo	or Cobb	Grav	Sand	Silt	Org	K gi	緩	9
Dewatto Dewatto Dewatto	15 420 15 420 15 420	, 16,	18 0.0 3.5 7.5			-M-	26.3 20.0 20.0	9.0	8,8% 8,80	20.26	:	:	;	!	:	20.3	-	0.7.5 W.V.C	5.7	W.V.C
Dewatto Dewatto Dewatto		Nov 24 Dec 3,8 Dec 8	8.7.6 7.9	7.88 9.7.8	1893 4700 376	w-v	100.0 7.9 20.0	2.0	5%8 0.2.0	0.0	0-0			% 0 0 0	- 56 20.0	20.00 0.00		10.0 40.0	8.28 00	000
FFite ite	15 421 15 421 15 421	Dec 4 Dec 7 Dec 7	0.4.6		55	~m~	5.6 85.0	0.00 0.00	100.0		97.9	000	Ŋ,	82.7	-	0.00	-	5 w n	8.0.0	9.0.6
子 子 ite			2.05	2.2	203 177 1288	1W 0/4	35.0 612.0	000	100.00	000	000		000	000		808		0000	835	0000
unnamed	15 422	Dec 14	0.0	6.0	5797	-	7.0	6.5	9.0	0	91.0	0	8.6	75.8	15.5	0.0	0	56.3	50.6	2.0
unnamed	15 423	Dec 9	0.0	9.0	3080	-	5.3	5.5	24.2	29.5	9.67	0	3.2	62.8	25.6	3.4	0	2.62	83.4	2.2
Shoe Shoe Shoe	15 424 15 424 15 424	Nov 23, Dec Dec 3 Dec 3	3 0.0 1.9 2.4	2.5 4.5 6.4	11000 3000 1250	-04	9.3 0.0 320.0	4700	28.9 0.0 100.0	 	9.69	0 8 0 0	10.3 0.0	7.9 0 0	15.3 0 1	100.0	000	20.9 5.0	49.5 20.0 20.0	7.0
unnamed	15 424A 15 424A	Dec 14 Dec 14	0.0	0.0	4017 753	4	3.8	3.5	23.5 100.0	15.0 6	2.19	00	8.0	66.69 0	27.1	0.001	~ 00	81.2 5.0	65.9	2.6
unnamed	15 425	Dec 14	0.0	0.2	1000	-	3.0	8.3	20.0	10.0	0.07	0	15.0	0.02	15.0	0.0	0	90.0	0.09	3.0
unnamed	15 426	Dec 9	0.0	8.0	5035	-	7.4	3.3	23.9	25.9 5	50.2	0 0.2	29.1	26.0	14.8	0.0	0	65.3	33.0	2.8
unnamed	15 429 15 429 15 429	Dec 7 Dec 7 Dec 7	0.00		422 1312 3874	-2-	00m 900m	0.5 5.1 5.1	50.0 22.0	50.0	0 0 0 0 0 0 0 0 0 0 0 0 0	000 00w	27.9	30.0	20.0	50.0	000	60.0 80.0 87.8	30.0 39.2	200
unnamed	15 434	Dec 15	0.0	1.3	2000	-	5.9	8.4	8.0	0.7	91.3	8.4.8	10.0	70.0	15.2	0.0	0	62.1	20.3	1.7
Ludvick Lk	15 435	Dec 16	0.0	9.0	3360	-	6.2	5.4	13.0	0	0.78	0	3.5	78.5	16.5	1.5	0	29.0	41.0	1.0
Windship Windship	15 436 15 436	Nov 25 Nov 25	0.0	0.5	2972 428	-w -	6.6	0.0	100.0	25.5 4	7.77	00	0.7	61.0	35.1	3.2	•	8 6.8 5.0	52.4 70.0	2.0
unnamed unnamed unnamed	15 437 15 437 15 437	Dec 15 Dec 15 Dec 15	0.0	1.38	400 4904 3296	01 <u>-</u> 4	0.0 4.0 88.0	93.6	18.8 100.00	1.0	0.00	0 × 0 0	34.9	54.1	8 0 0 0	0.0	000	30.0 5.0	20.0 54.7 50.0	0.40
unnamed	15 4378 15 4378	Nov 25 Nov 25	000	MW. 000	111	-м	70.0	0.0	41.0	00 N	59.0	00	00	15.0	40.0	45.0	00	20.0 10.0	80.0 80.0	2.0

Table 4, continued.

Stream	Stream	+ _		₹.		0.00	40.00			Pe Habit	Percent Habitat type	æ	•	Percent	Substrate	rate			;	;	
Kame	Number	Dates	es	Ş	- D	(ft)	Type	(ft)	Grade	Pool	Glid	Rif L	edg Bo	or Cobb	Grav	Sand	Silt	org 0	Can Can	OKBV	9
unnamed	15 437A 15 437A	200	ммі	0.0	4.0	~~	-w	.0.0 .0.0	4.0 5.5	37.0 100.0	00	23.0 0.0	00	1.2	0.0	1	5.0 0.0	00	83.0	88.0 0.08	.0.0
unnamed		ပို့ ပို့	-0 to	9.0	0.0	925 1550	~ ™	%.0 0.0				30.0				4	98.0	00	200	88	00
Tahuya		× × ×	24, 30	12.0	1.7	13193	M	17.8				24.5		ľ	74.2	4	8.7	0	40.1	61.5	1.7
Tahuya		200	Dec	2 14.9	72.7	9867	n ← 1	17.6				21.7		S	53.	v. 0.4	3.5 0.4.	00	52.5 52.0 8.0	88 6v	23.0 3.0
Tahuya		2 0	4 C	16.1	16.3 - 2.3	2026 2056	√	3.X 5.0		92.0	00	00				0 5	5 5 5 5	00	<u> </u>	88	0.6
Tahuya		ပ္ပ ဝ ဝ	 	16.3 17.2	17.2 17.4	6325 1529	⋈ ←	0.02			50-0				; ;			000	50.0	88	200
Tahuya Tahuya		မှ မို	≅	14.8 18.2	18.2	2142 9056	M-	7.7 7.7			, 75 10.6 10.6	32.6	-	27	•	3,4,7 5,0,0	28.0 8.0 8.0	000	10.0 57.8	885 20.4	900
Tahuya			_ 2 9	50.7 10.7 10.7 10.7 10.7 10.7 10.7 10.7 1	- ×:	1580 1580	4 W. ←	85.0 8.0 9.0			00	00					88	00	2.0	00	00
Tahuya Tahuya Tahuya	13.75 44.65 44.65 44.65		222	200 8.6.5	2.02 2.03 2.03 2.03 2.03 2.03 2.03 2.03	1797 1136 1136	hJ	30.05 30.06	ຼຸ ທີ່ທີ່ຄັ້	70.05		9.00	000	000			552	000	K 25	20.0	000
Tahuya		E	5	21.0	21.2	1651	·M	30.0							2.0	9.0. 9.0.	88.0.0	00	20.0	38 50	20.0
Buffoon	15 470	Dec	31	1.2	1.5	1530	•	14.0	1.0	. 0.84	29.0	23.0	0 0	0.04	45.0	10.0	5.0	0	80.0	50.0	2.0
unnamed	15 471 15 471	Dec	5 5	0.0	0.3	055 055	-m	12.9 50.0	0.0	7.00	14.3	0.0	00	00	5.0	19.0	0.00	00	2.0	87.1 90.0	2.0
unnamed unnamed unnamed	15 472 15 472 15 472 15 472		<u> </u>	0000	0.00	1100 1100 1725 2850	n-w4 Φ	0.0 6.0 45.9 800.0	8800	0.050 89.00 0.050	20.0 10.1 0.1 0.1	0.00	0000	0000	90.00	20.0 20.0	8.v.8.5	0000	0.00°c	8.0.8 0.0.0.0	0000
Plog	15 474	Dec 1	_	0.0	8.0	4300	-	9.0				7.07	0 8.6	15.6	30.3	22.2	23.3	. 0	57.2	41.4	5.
unnamed	15 475	Jan	15	0.0	0.2	1400	-	5.0	4.5	30.0	20.05	50.0 4.	0 0	25.0	36.0	35.0	0.0	0	75.0	20.0	2.0
unnamed	15 477A	Dec	30	0.1	0.3	1173	-	4.0	1.6	7 0.07	70.05	20.02	0 0	0	40.0	40.0	20.0	0	70.0	0.09	2.0
Union Union	15 503 15 503	Dec	21,22 22,	6.0	6.5 6.53	7650 3160	**	13.0 8.7	3.2	52.4	21.6 22.22	26.0 64.9 0.	0 7 38.5	31.5	39.9	44. 4.6.	15.7	00	40.4	32.6	2.0
E.F. Union	15 512	Dec 2	<u>.</u> .	0.0	0.3	1435	-	7.2	0.7	24.9	۲.۲	0	0 0	0	1.4	10.0	88.6	0	30.0	50.0	1.0
McTaggert	16 105	Dec 7		0.0	3.0	16170	-	11.4		10.01	20.0 7	20.0	0 13.1	1.67	27.8	6.6	0	0	4.29	7.0	9.1
Duckabush Duckabush	16 351 16 351	Nov 6	2 6	0.2	6.3	12258 10000		55.0 42.9	40	31.1	35.5 3	33.4	0 0.3	7.7	62.3 20.1	20.9	8.0 0	00	1.1	1.1	2.0
unnamed	16 362	Nov 1	12	0.0	0.2	1148	-	7.1	0.5	97.29	0	37.4	0	7.4	54.9	12.6	10.01	5.1	86.3	72.6	3.0
Ripley	17 89	Dec	17	0.0	0.7	3280		6.9	1.3	29.0	39.0 3	32.0 6.	0 3.0	18.5	54.5	18.0	0	0	35.0	45.0	1.9

Table 5. -- Number of juvenile coho and other fish collected during electroshocking of several pools in two tributaries of Tahuya Lake in August, 1994. Cutthroat trout were visually divided into four length categories; A = < 80, B = 81-110, C = 111-140, and D = >140 mm fork length. All lamprey collected were ammocoetes. WRIA = Water Resource Inventory Area.

	WRIA + Stream		Pool		maximum depth		#		Cutth	roat 1	rout	#	#	#
Stream Name	Number	Date	#	ft ²	(ft)	seconds	Coho	A	В	C	D	Dace	Sculpin	Lampre
Tahuya R.	15 446	Aug 18	1	57.0	0.98	65	0	2	0	0	0	0	0	0
(RM 20.4-20.)	7)	Aug 18	2	123.7	0.79	65	0	1	2	1	0	0	0	0
		Aug 18	3	128.0	1.12	67	0	4	1	1	0	2	0	0
		Aug 18	4	529.3	1.87	238	0	11	2	1	0	4	0	0
		Aug 18	5	267.9	1.31	109	0	0	2	2	0	0	0	1
		Aug 18	6	89.3	0.85	66	0	1	1	0	0	0	0	0
		Aug 18	7	97.9	1.28	118	0	0	4	5	0	0	0	0
		Aug 18	8	206.6	1.64	185	0	2	2	2	0	0	0	0
		Aug 18	9	90.4	0.56	47	0	4	0	3	0	0	0	0
		Aug 18	10	901.6	1.44	498	0	9	12	3	0	1	0	4
		Aug 18	11	471.2	2.95	182	0	7	2	0	0	3	0	0
		Aug 18	12	166.8	0.56	99	0	3	1	0	0	0	0	0
		Aug 18	13	207.6		131	0	5	2	0	0	0	0	0
		Aug 18	14	306.6		194	0	3	2	3	0	2	0	0
		Aug 18	15	650.9	2.56	194	0	0	3	1	0	0	O	0
	Totals			4294.8		2257	0	52	36	22	0	12	0	5
iold Cr.	15 474	Aug 18	1	245.3	1.48	152	2	2	3	2	4	29	1	0
(RM 0.1-0.5)		Aug 18	2	109.7	0.75	68	0	10	1	0	0	10	2	0
		Aug 18	3	185.0		114	0	9	1	0	0	3	6	0
		Aug 18	4	159.2	0.98	123	1	9	1	0	0	11	8	0
		Aug 18	5	63.5	0.75	86	0	1	1	0	0	6	2	0
		Aug 18		118.3		9 1	1	4	3	1	0	10	2	1
		Aug 19		190.4	1.38	175	3	2	5	2	1	17	3	2
		Aug 19		170.0	••	174	3	10	11	2	0	13	3	0
		Aug 19		190.4	1.94	177	2	1	6	4	2	23	0	0
		Aug 19	10	150.6	1.64	202	2	9	6	5	0	19	8	0
		Aug 19	11	324.9	2.07	267	5	13	6	1	1	19	6	0
	Totals			1907.5		1629	19	70	44	17	8	160	41	3

Table 6. -- Summary of summer low-flow habitat survey data collected on two tributaries of Tahuya Lake in August 18-19, 1994.

Tahuya Riv	ver (RM 20.4-20.7)	Gold Creek (RM 0.1-0.5
Total length (ft)	1601	2398
Percent of total length sampled	65.7	45.3
Total area (ft ²)	10818	16007
mean width (ft)	6.76	6.67
Habitat types (%)		
Pool	93.0	48.6
Scour pool	69.0	48.6
Dammed pool	21.6	0.0
Backwater pool	2.4	0.0
Tailout	0.0	4.9
Glide	0.0	5.8 34.7
Riffle Cascade	6.7 0.3	6.0
Pool data		
Total number of pools	33.3	42.2
mean maximum depth (ft)	1.49	1.1

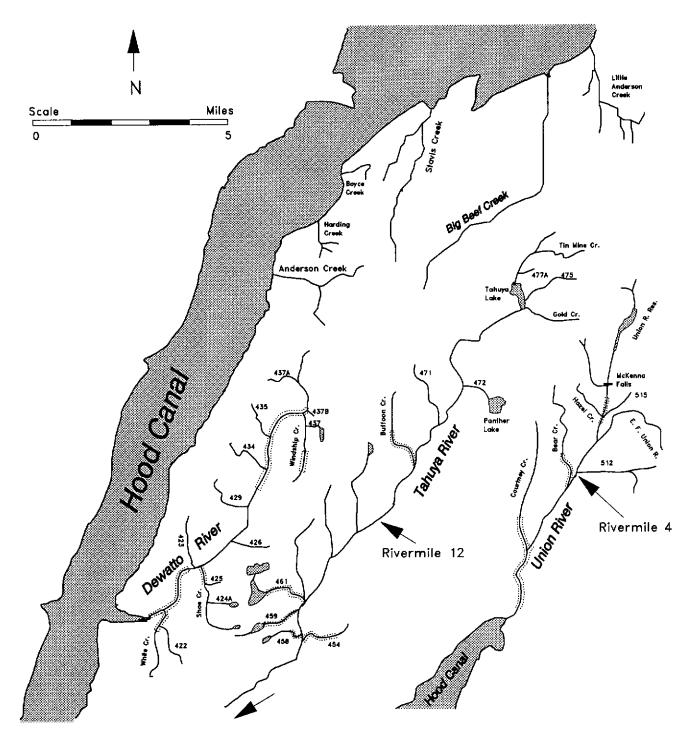


Figure 1.-- Map of southeastern Hood Canal streams surveyed for supplementation evaluation. Surveys were done on the mainstem and tributaries of Dewatto River, Tahuya River above rivermile 12, and Union River above rivermile 4. Preliminary surveys were also done in Little Anderson Cr., Stavis Cr., Boyce Cr., Harding Cr., and Anderson Cr. drainages. Unnamed streams are labeled according to the stream numbers of WDF Stream Catalog. Highlighted stream sections are WDFW chum and coho salmon index sections.

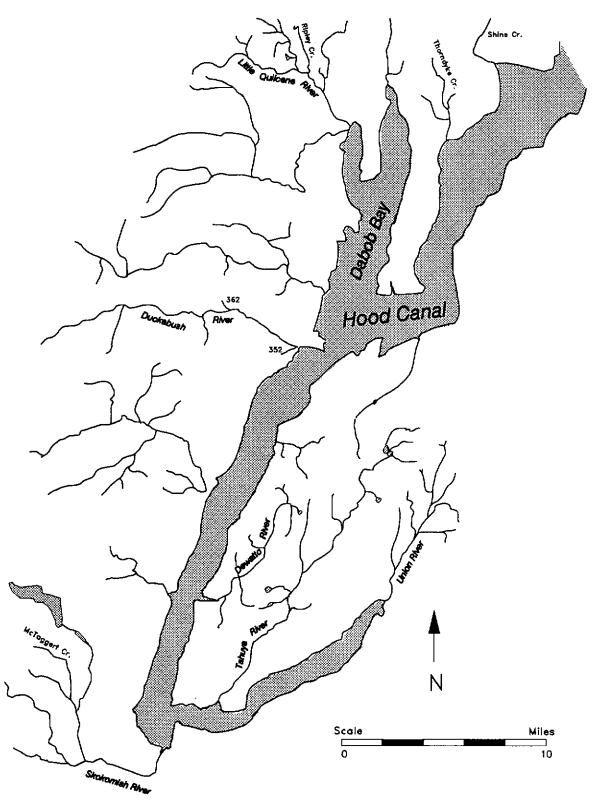


Figure 2.-- Map of other Hood Canal streams surveyed for supplementation evaluation. Study streams in southeastern Hood Canal area are given in Figure 1.

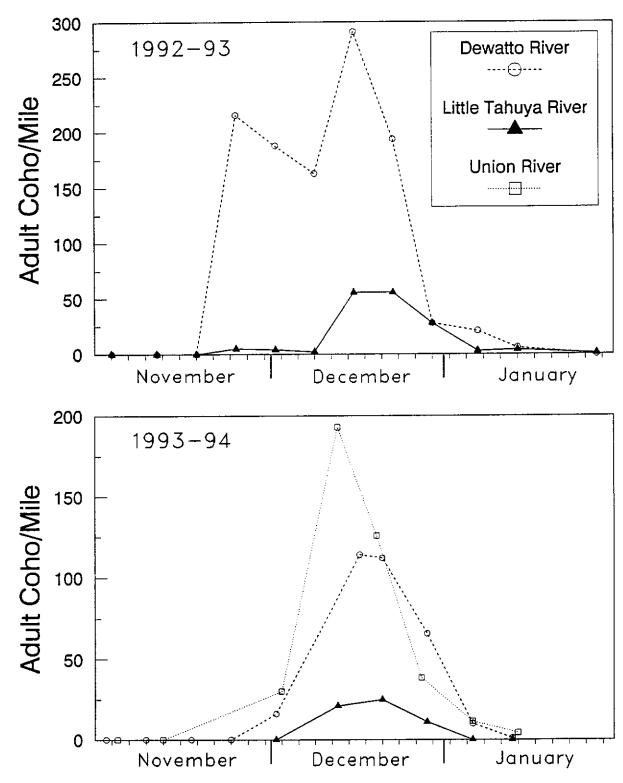


Figure 3.-- 1992-3 and 1993-4 weekly counts of adult coho salmon in WDF stream index sections for Dewatto River, Little Tahuya Creek, and Union River. Few fish were observed in the Union River index section during 1992-3 surveys.

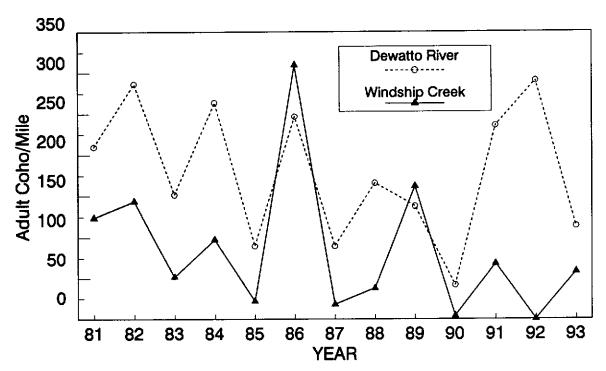


Figure 4.-- Peak adult coho salmon counts of two WDFW stream index sections in the Dewatto River system from 1981-93. Dewatto River (15.0420) index section is at rivermile 4.8-5.8. Windship Creek (15.0436) enters the Dewatto River at rivermile 7.3 and the index section is upstream at rivermile 1.1-1.8.

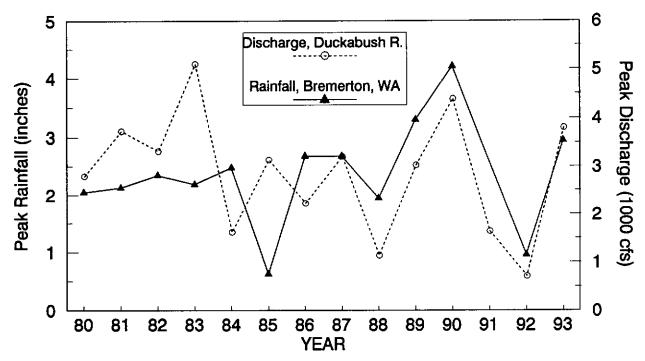


Figure 5.-- Peak rainfall and discharge for November-December of 1980-1993.

Rainfall data was collected by U.S. Weather Service at Bremerton,

Washington. Discharge data was collected by U.S. Geological Survey at
rivermile 4.5 on the Duckabush River.

Appendix A. -- Habitat survey data collected for Hood Canal streams from November 1992 through January 1993.

Feet is the distance from the stream's mouth except for Tahuya River which starts at RM 12 and Union River which starts at RM 4. Reach Type: 1 = wetted stream, 2 = dry stream, 3 = large beaver pond/marsh, 4 = lake, 5 = braided stream. Glid = glide; Rif = riffle; Ledg = ledge/bedrock; Bou = boulders; Cobb = cobble; Grav = gravel; Org = Organic debris; % Can = % overhead canopy; % OHBV = % overhanging bank vegetation; WD = woody debris; Grad = gradient.

WRIA +		₹ :	¥			;			Percent Habitat type	8		Perce	Percent Substrate	bstra	9	;	> *	>		
Stream	Date	2 2		Feet	(Ft) W	idth	Type	P001	Glid Rif		Fed B	ည	Bou Cobb Grav	av Sai	Sand Silt		_ :	OKBV	3	Grade
Dewatto River	•							 	• • • • •											
15 420	02-Nov	0.0	0.7	200	200	30	-	0	86	=	0	0	'n	₩.	₽	0	ន	-	₹	0
15 420	02-Nov	0.0	0.7	1000	200	30	-	ø	28	8	0	0	ιΛ	ĸ	ຂ	0	8	5		1.0
15 420	02-Nov	0.0	0.7	1552	552	35	-	22	2 6	22	0	0	ľ	ĸ	ន	0	옸	<u>ب</u>	3	1.0
	02-Nov	0.0	0.7	2108	556	8	-	٥	3	23	0	0	12	ĸ	5	0	04	5	ÆD10₩	1.0
	02-Nov	0.0	0.7	2450	342	30	-	58	32	10	0	0	Ŋ		Ю	0	65	ا	色压	-0.
15 420	02-Nov	0.0	7.0	3155	705	30	-	2	33	51	0	0	Ś	8	~	0	23	0	₹	0.
	02-Nov	0.0	0.7	3601	446	32	-	8	0	7	0	0	2	23	ξ.	0	유	0	HED ION	1.0
15 420	02-Nov	0.0	0.7	4028	427	Ю	-	23	54	65	0	0	0		ĸ	0	ĸ	-	HEAVY	1:0
15 420	02-Nov	0.0	0.7	4488	460	30	-	7	38	55	0	0	0		30	0	7 0	~	AED IGN	0.
15 420	02-Nov	0.0	0.7	5028	540	30	-	25	0	48	0	0	0	2	요	0	ಜ	m	35	0.
15 420	05-Nov	0.7	€.	6056	1028	8	-	%	36	32	0	0	~	63	33	7	2	m	ž	1:0
	05-Nov	7.0	1.8	7057	1001	30		45	5	07	0	0	~	23	33	~	32	∞	ED ICH	-0:
	05-Nov	7.0	÷.	06 62	933	30		38	40	25	-	0	0	65	ි ස	4	9	~	3	-0.
	05-Nov	0.7	<u>.</u> ∞.	9028	1038	32	-	20	45	33	0	0	м	29	x	S	20	∞	3	0.
15 420	05-Nov	0.7	8.	10062	1034	Ŋ	-	99	0	24	0	0	5	2	ង	~	8		HEAVY	1.0
	05-Nov	0.7	.	11076	1014	8	-	40	4	41	0	0	'n	2	_N	~	x		MED IUM	-0
	05-Kov	0.7	£.	-	1010	22	-	25	51	27	0	0	'n	2	ĸ	~	20	2	MED I UM	٠.
	16-Nov	1.8	3.2	13073	786	23	-	Ŋ	37	07	0	0	9	80	유	0	2	Ŋ	3	<u>-</u>
15 420	16-Nov	1.8	3.2	14031	958	53	-	33	32	30	0	0	2	ဓ္ဆ	2	0	8	1 0	MEDICA	0.
15 420	16-Nov	.8	3.5	15116	1085	53	-	94	54	8	0	0	15	2	5	0	ន្ត	Ŋ	<u> </u>	1.0
	16-Nov	~ .	3.2	16244	1128	Ю	-	%	37	23	0	0	2	2	2	0	40	'n	3	0.
15 420	16-Nov	٠. ه	3.2	17284	1040	ଷ	-	32	46	16	0	0	'n	8	'n	0	2	S	3	0.
	16-Nov	<u>.</u> ∞.	3.5	18198	914	웄	-	40	5 8	ž	0	0	5	2	15	0	8	2	3	-
	16-Nov	8:	3.2	19152	954	2	-	21	33	3	0	0	S	2	អ	0	င္တ		#EDIG#	-
	16-Nov	1.8	3.2	19986	834	23	-	٥	36	22	0	0	2	ĸ	ı,	0	8	'n	3	0
15 420	18-Nov	3.2	4.0	21130	1144	£	-	28	75	8	0	0	īŪ	8	'n	0	8	Ŋ	MEDICA	1.0
15 420	18-Nov	3.2	4.0	21689	559	ង	-	35	አ	75	0	0	15	2	5	0	8	S	3	
15 420	18-Nov	3.5	4.0	24214	2525	100	м	9	0	0	0	0	0	'n	2	82	9	S	HED I CH	<u>.</u>
15 420	18-Nov	3.2	4.0	24436	222	33	-	2	30	0	0	0	0	10	07	20	2	9	10 5	0.
15 420	18-Nov		4.0	27089	2653	240	m	<u>0</u>	0	0	0	0	0	0	_	&	'n	8	<u>1</u>	-0
	27089		5912			WDFW index	dex ar	èa									i	i		,
15 420	24-Nov	7.5	7.9		608	ଯ	-	Ņ	2	&	0	0	0	30	S S	20	2	8		0.
15 420	24-Nov		7.9	48413	1893	9	M	9	0	0	0	0	0	0	-	8	9	8	AED I CA	0.

Appendix A, continued.

trib of 420 (2b) (2b) (2b) (2b) (2b) (2b) (2b) (2b)	4 4101		3	3					. tet	hitet to	9		90.00	- to	hetra	•					
	FEGGTAS		<u> </u>			Jistano		Reach			· ! :						÷		><		
### ### ### ### ### ### ### ### ### ##	Number	Date	Ē		Feet	(Ft)	idth	Type		Glid		edg B	3	do Gr	es ve	nd Si			¥8	9	Grade
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Appendix A, continued.

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Appendix A, continued.

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Appendix A, continued.

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